

Patent Application

Of

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For

**BICYCLE CHAINRING FASTENER SYSTEM**

**TECHNICAL FIELD**

The present invention pertains to nut and bolt fastener assemblies for use on bicycle crank assemblies.

**BACKGROUND OF THE INVENTION**

Typical human powered bicycles are propelled by pedals mounted on cranks at opposite ends of an axle. The cranks drive one or more sprockets, or chainrings, which in turn engage a chain to transfer the rotary motion of the cranks to a rear wheel. In typical crank assemblies one or more chainrings are mounted to one of the crank arms by fasteners.

These fasteners attach the chainrings to the support arms radiating from a central hub of the crank. The hub of the crank in turn rotates on an axle rotatably mounted in the bicycle frame.

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A common way of securing the chainrings to the crank involves corresponding holes in each piece, with the fastener system passing through the holes and securing the pieces together. There are currently two types of fastener systems employed for this purpose: rivets or nuts and corresponding bolts. It is desirable for the design of this fastener system to occupy as little volume as possible to allow for other piece(s) of the assembly to fit in the same area, to provide clearance to a moving chain, and simply for aesthetic reasons.

For rapid and easy assembly and reduction of cost rivets are most commonly used as a fastening system on inexpensive bicycle cranks. Due to their low profile, rivets satisfy the desire to minimize the fastener volume. An inconvenience of this arrangement is that by nature, rivets are a permanent fixing device, requiring destruction of the rivet if the unit must be disassembled.

To allow for servicing of individual chainrings a nut and bolt fastener system is typically used on more expensive bicycle cranks. A nut and bolt system for attaching chainrings to the crank has existed for decades with the characteristics shown in Fig. 1. In this system the bolt is comprised of an externally threaded shaft, a flange on one end, and a tool interface. The tool interface is most commonly a hex profile cut into the center of the flange and shaft section, although other types of common tool interfaces are occasionally used. The nut is comprised of a shaft with an internal thread passing through its entire length, an exterior flange, and a tool interface cut into the flange. This tool interface comprises of a slot requiring a special tool to hold the nut during assembly or removal. Since it is desirable to minimize the volume of the fastener system the flanges of the nut

and bolt are kept relatively thin, which results in a minimum tool engagement depth for the nut.

The nut and bolt of the current state-of-the-art are assembled such that the external thread on the bolt is inserted into, and corresponds with, the internal thread on the nut. The nut is threaded completely through to allow the threaded end of the bolt to protrude to the outside of the flange on the nut. The nut and bolt secures the chainring(s) to the crank support arms by using the exterior cylindrical surface of the nut's shaft as a locating device, and by exerting a clamping force on the objects being assembled through the pressure exerted by the flanges of both the nut and bolt resulting from tightening the nut and bolt together. Examples of such nut and bolt fastener systems as just described are shown in patents relating to cranks and chainrings such as U.S. 5 480 359 and E.P. 0 002 903.

## SUMMARY OF THE INVENTION

One object of the present invention is to provide a fastener system for mounting bicycle chainrings to bicycle cranks that provides for a combination of high fastener and tool engagement strength. The inventor has recognized that the maximum pressure exerted to secure a chainring to a crank arm is a function of the ability to convert tightening torque into fastener tension. High fastener tension is desirable not only because it securely fastens the chainring(s) to the crank support arms but also because it prevents the nut and bolt system from loosening during use of the crank assembly. The transfer of tightening torque into fastener tension is governed by the strength of the fastener and the strength of

the tool interface. It is therefore desirable to provide a fastener assembly with high fastener and high tool interface strength.

Another object of the present invention is to provide a fastener system that is simple and fast to assemble or disassemble. The inventor has recognized the need for improved tool engagement interfaces on the nut and bolt fastener system such that automated assembly tools and fixtures can easily hold either the nut or bolt from either the inside or outside of the crank assembly. In this manner, assembly of the chainring(s) onto the crank can be accomplished in a simple, flexible, efficient manner.

According to the above objects, the present invention provides for an improved fastener system for attaching one or more chainrings to a bicycle crank arm consisting of a nut and bolt with the following features:

The bolt of the present invention consists of an externally threaded shaft with a flange on one end. A tool engagement interface is provided on the interior of the shaft, such that a tool can be used to rotatably hold or tighten the bolt. The external thread diameter and tool interface size and depth are structurally optimized to provide for a compact bolt that can still fit the existing interface holes in typical bicycle cranks and chainrings. A substantial strength increase over existing chainring bolt designs is therefore achieved. Thus, the clamping force generated by the fastener assembly is greatly increased and the propensity of the fastener system to loosen during use is diminished or eliminated.

The nut of the present invention consists of an internally stepped cylinder with a flange on one end. A tool engagement interface is provided on the smaller internal diameter of the cylinder, adjacent to the flanged end, such that a common tool can be used to rotatably hold or tighten the nut. Threads are formed on the larger internal diameter part of the cylinder and mate with the corresponding exterior threads of the bolt. The size of the internal threads of the nut, and thus the bolt, are structurally optimized to provide for a compact fastener system with exceptional strength that still fits existing interface holes in typical cranks and chainrings. Additionally, the size of the tool engagement interface is structurally optimized relative to its depth and the outside diameter of the cylinder to provide for the greatest possible tool engagement and nut strength.

Since both the nut and bolt of the invention include tool interface portions that are internal to their diameters and structurally optimized to provide for high tool engagement strength, either the nut or the bolt can be effectively used on either the outside or inside of a crank and chainring assembly. Thus, assembly of the chainrings on the crank can be performed in the most efficient manner to meet the requirements of the assembler.

Further, the use of high strength internal tool engagement interfaces makes automation of the assembly process, especially the fixtures or machines that rotatably tighten the fasteners, much easier to implement and maintain than the traditional nut and bolt system.

Other benefits and advantages of the present invention will become apparent from the following detailed description of a preferred embodiment of the invention with reference to the drawings.

## BRIEF DESCRIPTION OF DRAWINGS

**Fig. 1** is an enlarged, exploded, fragmentary perspective view of the common prior-art nut and bolt fastener system used to attach the two largest chainrings to a bicycle crank support arm.

**Fig. 2** shows a side view of a bicycle.

**Fig. 3** is an enlarged perspective view of the crank and chainrings from the bicycle of Fig. 1.

**Fig. 4** is an enlarged, exploded, fragmentary perspective view of the nut and bolt fastener system used to attach the two largest chainrings to the bicycle crank support arm from Fig. 3.

**Fig. 5** is an enlarged, fragmentary, radial cross-sectional view of the assembled nut and bolt fastener system, chainrings, and crank from Fig. 4.

**Fig. 6** is a perspective view of the bolt from the fastener system of Fig. 4.

**Fig. 7** is a perspective view of the nut from the fastener system of Fig. 4.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Fig. 2 generally shows a bicycle **10** with a bicycle frame **12**, on which are mounted cranks **14, 16** with pedals **18**. Crank **14** is an assembly comprising of the crank arm with fastener systems attaching a plurality of chainrings to the crank arm.

Fig. 3 shows an enlarged perspective view of the crank **14**. Chainrings **20, 22** are rotatably secured to the support arms **24** of crank **14** by fastener systems **30**.

Fig. 4 shows the preferred embodiment of the fastener system **30**, which comprises of a bolt **40** having an exterior flange **42**, an exterior thread **44**, and a tool locating area **46**; and a nut **50** having an exterior flange **52**, an exterior cylindrical mating surface **54**, an internal threaded bore **56**, and an internal tool locating area **58** that is not visible in this view. The bolt **40** and nut **50** assemble to each other such that threads **44** and **56** correspond to each other and assemble as a standard nut and bolt combination. This assembly of the bolt **40** and nut **50** fasten together an inner chainring **20** and an outer chainring **22**, with a crank support arm **24** clamped therebetween. In this instance flange **42** of the bolt **40** is mated to the inner chainring **20** while the flange **52** of the nut **50** is mated to the outer chainring **22**. The external cylindrical mating surface **54** of the nut **50** is closely matching in size to the fixing holes generally indicated as **26** provided in the chainrings **20**, **22** and the crank support arm **24**. In this manner the inner and out chainrings **20**, **22** are co-located with the crank support arm **24** through the mating cylindrical surfaces **54** and **26**. The entire assembly is held fast by rotating the bolt **40** or nut **50** in the direction of engagement for the mating threaded portions **44** and **56**. The bolt **40** or nut **50** are rotated relative to each other by engaging corresponding tools into the tool interfaces **46**, **58** and rotating one tool relative to other. As these pieces rotate relative to each other in the direction of engagement for the mating threaded portions **44** and **56**, flanges **42** and **52** come into contact with and exert pressure on the inner and outer chainrings **20**, **22**. This condition is shown in Fig. 5.

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It is important to generate sufficient tension in the fastener assembly **30**, and thus clamping pressure in the assembled members **20**, **22**, and **24**, to fixedly hold the entire assembly together and prevent the fastener assembly **30** from loosening during use. This is accomplished by structurally optimizing the sizes of threaded portions **44** and **56** and the tool engagement interfaces **46** and **58**. In the preferred embodiment the outside diameter of the exterior thread **44** is 8.5mm with a thread pitch of 0.75mm. The interior threaded portion **56** of nut **50** is correspondingly sized. The tool engagement interface **46** in bolt **40** is a hexagonal shape with a distance across the flat surfaces of the hexagon of 5mm and extends entirely through the center of bolt **40**. Other tool interface shapes may also be used, such as crosses, splines, or other multi-lobed interfaces shapes. This combination of thread size, pitch, and tool engagement interface **46** results in an approximately homogeneous strain distribution throughout the general cross-section of the bolt **40** and nut **50**. In this way the strain energy stored in the fastener system **30** resulting from tightening the bolt **40** and nut **50** together is maximized to prevent loosening of the assembly during use.

The structural optimization of the fastener system as just discussed, combined with the improved strength of the internal tool interfaces **46**, **58**, allows the bolt **40** and nut **50** to be made from lightweight materials that previous fastener systems have been unable to employ. For example aluminum, plastic, or composite materials may be effectively used to decrease the overall weight of the crank assembly, thereby providing the bicycle rider with an improved power to weight ratio.



In Fig. 5 it can be seen that the tool interface **58** in the nut **50** is not as deep as the tool interface **46** in bolt **40**. This is a result of maximizing the number of threads **44** in engagement with corresponding threads **56**. The tool interface **58** in nut **50** is a hexagonal shape similar to that in the bolt **40**, but with the distance across the flat surfaces of the hexagon being equal to 6mm. In this manner, even though the tool engagement depth for the nut **50** is not as deep as that for the bolt **40**, the larger tool size results in a torque capacity for the nut **50** equal to that for the bolt **40**. Thus, either the bolt **40** or nut **50** may be rotated relative to the other to achieve the proper fastener tension in the assembly.

Further, since both tool interfaces **46**, **58** are interior to the bolt **40** and nut **50**, the bolt **40** and nut **50** look similar to each other. Thus, either the bolt **40** or nut **50** can be used on the exterior of the crank without worry of the aesthetic controversies surrounding the choice. In this way the fastener system **30** is adaptable to many different assembly methods. Further, due to the relatively deep internal tool interfaces **46** and **58**, it is much easier to design automated assembly fixtures and tools to mate to and fixedly hold either the bolt **40** or nut **50**. Again, this makes the fastener system **30** very adaptable to various assembly methods and procedures.

Although the invention has been explained in relation to its preferred embodiment, it is to be understood that many other possible modifications and variations can be made without departing from the spirit and scope of the invention as hereafter claimed.